



Green Jackfruit Transformation: Dry Flour Processing, Nutraceutical Analysis, and its Revolutionary Application in Maintaining Optimum Blood Glucose Level

Anika Tasnim¹, Md. Rezaul Karim^{2*}, Ferdous Ara Mukta², S. M. Rashadul Islam², Md. Rakibul Hasan², Bishwajit Bhowmik³ and A. K. Azad Khan³

¹Biological and Toxicological Research Division, Bangladesh Council of Scientific and Industrial Research, Chattogram-4220, Bangladesh.

²Institute of Technology Transfer and Innovation, Bangladesh Council of Scientific and Industrial Research, Dhaka-1205, Bangladesh.

³Center for Global Health Research, Diabetic Association of Bangladesh, Dhaka-1205, Bangladesh.

*Corresponding author. Md. Rezaul Karim Email: ittibcsir2020@gmail.com; Phone: +8801711546720; ORCID: 0000-0002-8439-2499

Received: 22/06/2025

Accepted: 23/08/2025

Available online: 26/08/2025



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Abstract: The high moisture and sugar content of ripe jackfruit often leads to spoilage and challenges in processing. This study explores the potential of dry green jackfruit flour as a solution, particularly for vegan meat applications. Fresh, mature, unripe jackfruit was processed, sliced, and dried using a Heat Pump Dryer under controlled conditions. The resulting flour was then evaluated for its nutritional attributes, including proximate composition, minerals, vitamins, amino acids, and antioxidant properties. The dry green jackfruit flour exhibited a promising nutritional profile with 6.04% moisture, 12.27% crude protein, sugar 37.57% carbohydrates, and a low 1.59% lipid content, making it an ideal low-fat protein source. Importantly, it is gluten-free (0% gluten) and contains 3.28% ash. Additionally, it boasted a substantial 12.21% crude fiber content, and a significant mineral content, including potassium (1540 mg), calcium (205 mg), and sodium (21.6 mg) per 100g. Its amino acid profile was noteworthy, with high quantities of key amino acids such as aspartic acid (20.6%), glutamic acid (11.4%), and alanine (10.0%), along with essential amino acids like lysine (6.0%) and leucine (6.7%). The flour's biochemical analysis confirmed the presence of citric acid (0.00024 mg/g), ascorbic acid (0.01 mg/g), total carotenoids (0.13 µg/g), and a substantial total phenolic content (18.98 mg/g GAE equivalent). Moreover, it displayed promising antioxidant potential, with a DPPH activity IC₅₀ value of 2.9 mg/g. Heavy metal analysis indicated low levels of lead (0.1898 mg/kg), undetectable cadmium, minimal chromium (0.0 mg/kg), and low manganese levels. Consuming both jackfruit and wheat flour bread initially increased blood glucose significantly, with no significant changes at 30 mins to 1 hour, followed by significant decreases at 1-2 hours. These results affirm the flour's nutritional richness and safety, making it a valuable and versatile ingredient as lower glycemic index food.

Keywords: Jackfruit; Glycemic Index; Nutraceutical analysis.

INTRODUCTION

In the new millennium, with longer lifespans and more health coverage in the media, people are increasingly interested in the benefits of nutritional support for disease control and prevention (Wickramasinghe et al., 2020). As well, the global food industry has witnessed a growing

interest in sustainable and nutritious alternatives to traditional ingredients. Finding novel sources of dietary fiber for use in the food business has become popular in recent years, and the significance of food fibers has resulted in the growth of a sizable and promising market for fiber-rich goods and components (Chau and Huang 2003). Consuming foods high in fiber, such as cereals, nuts, fruits, and

vegetables, has been linked to a lower incidence of a number of diseases; therefore, it is beneficial for one's health (Albuquerque et al., 2020). The ability and worth of these high-quality, safe, and healthful foods—as well as other substitute sources of nutrient-dense foods like plants—are necessary. Numerous studies have been carried out to find low-cost and sustainable ways to replenish the necessary nutrients from various plant sources, including chia seeds (Otondi et al., 2020), soybeans (SB), and *Moringa oleifera* (Rweyemamu et al., 2015). These nutritional sources have demonstrated promising outcomes, particularly in combating micronutrient deficiencies in underdeveloped nations (Rweyemamu et al., 2015). But they are a costly source of dietary fiber for developing countries.

Poorer people find it hard to eat healthier because they can't always get or afford good food (Cleveland et al., 2020). They struggle to follow advice about eating more whole grains and less fat and sugar. This is because the kind of food around them, and how much it costs, makes it tough for them to eat better. Fixing this issue is important for helping low-income folks eat healthier (Jetter et al., 2006).

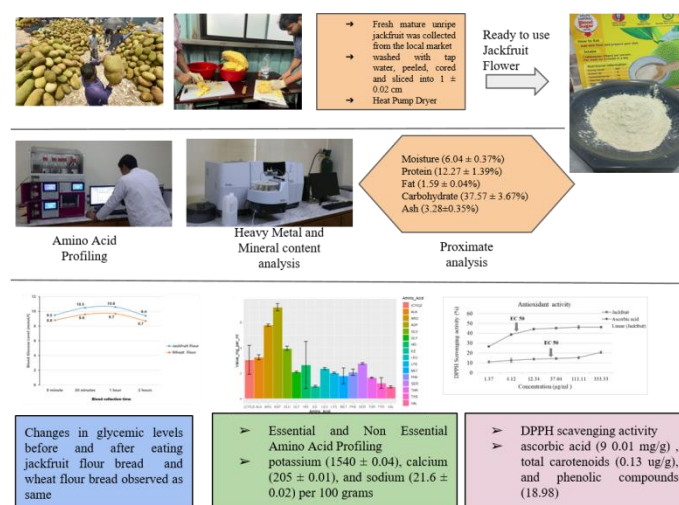
The jackfruit, native to parts of South and Southeast Asia, has long been valued for its versatility as both a culinary ingredient and a source of nutrition. The jackfruit is the second most produced fruit in Bangladesh and the third most cultivated fruit in the country. A total of 469,500 tons of jackfruit are produced annually on 25,110 hectares of land (BBS, 2000-2007). According to Das et al. (2020), it makes up around 22% of the nation's total fruit production. Known as "the poor man's food" due to its profusion and inexpensive cost, this tree is highly prized for both its fruit and lumber. In Bangladesh, jackfruits are typically consumed only when they are ripe and sweet. The issue arises when the fruit ripens during a season when many other fruits are also in their ripe stage, resulting in a large amount of wastage. According to officials, this leads to a loss of Tk 500 crore every year. However, the utilization of green, unripe jackfruit in the form of flour is a relatively novel concept that has gained attraction among health-conscious consumers, those seeking gluten-free alternatives, pesticide free and environmentally conscious individuals aiming to reduce their ecological footprint.

One such innovation that has gained attention is green jackfruit flour. Derived from the green, nearly mature stage of the tropical jackfruit (*Artocarpus heterophyllus*), green jackfruit flour presents a promising solution to the challenges posed by as jackfruit is used modern dietary preferences and health concerns including in helping prevent certain chronic diseases like cancer, cardiovascular diseases, and aging related diseases (Abuajah et al., 2015).

The increasing prevalence of type 2 diabetes mellitus (T2DM) globally necessitates the exploration of innovative dietary interventions to manage blood glucose levels effectively (Huda et al., 2021). Recent studies have indicated that traditional foods can play a significant role in glycemic control (Chaubey et al., 2019). Among these, green jackfruit

flour has emerged as a promising candidate due to its unique nutritional profile, which includes high fiber content and low glycemic index (Gupta et al., 2023).

Despite the promising attributes of green jackfruit flour, there remains a need for comprehensive research to unlock its full potential. By shedding light on these aspects, this paper seeks to contribute to a better understanding of green jackfruit flour's role in promoting sustainable nutrition, therapeutic application and fostering innovation in the food industry. This study investigates the acute effects of jackfruit flour bread on postprandial blood glucose levels compared to wheat flour bread.



MATERIALS AND METHODS

Sample Collection and Preparation of Dry Green Jackfruit Flour

Fresh, mature, unripe jackfruit was collected from the local market in Dhaka, Bangladesh. In the laboratory, jackfruit was washed with tap water, peeled, cored, and sliced into 1 ± 0.02 cm. The initial average moisture content was 83 % (w.b.). The jackfruit slices were dried at 50 °C for 14 hrs. Heat Pump Dryer was used, maintaining a constant 30% relative humidity and 1.5 m/s air velocity. Drying conditions were predetermined according to (Önal et al., 2019; Zzaman et al., 2021). Once dried, use a grinder to finely grind the slice of jackfruit into a powder. Then, to avoid moisture absorption, move the resultant flour into airtight containers and keep them out of direct sunlight in a cold, dry location. The entire green jackfruit flour production process used sanitized equipment.

Assessing of nutritional attributes

Proximal Analysis

An infrared moisture analyzer (Shimadzu, model MOC63u, Kyoto, Japan) was used to determine the moisture content of the dried samples. On an aluminum plate, three distinct 1,000-gram samples were dried at 105°C until they reached a constant weight. The percentage of mass lost

during this procedure was used to calculate the moisture content. To determine protein content by measuring nitrogen concentration, the Dumas combustion method (Ebeling, 1968) was employed. Before oxidative digestion at high temperatures with a regulated oxygen supply, samples were reduced and the carrier gas was cleaned. The remaining nitrogen content was determined using a thermal conductivity detector (VELP NDA 702) and a calibration curve that had been previously created. Petroleum ether was used as a solvent in Soxhlet extraction to ascertain the flour's fat content. Weighing the samples both before and after they were burned for 24 hours at 500°C allowed us to determine the amount of ash present (Haedrich et al., 2020). Total carbohydrate was estimated according to Mattila et al., 2018 formula.

Mineral and Heavy Metal Analysis:

With a few adjustments, the mineral content was calculated using the methodology described by Said Wahab (2010). 50 ml flasks containing 1g of jackfruit flour were filled with 10 ml of concentrated nitric acid and 5 ml of concentrated perchloric acid. The flasks were then digested on a hot plate until white smoke was produced. The answer became evident. The capacity was then increased to 100 ml by adding 20–30 ml of distilled water and filtering it. Atomic absorption was used to take the reading (Spectra A).

Antioxidant activity

Total Phenolic content and DPPH scavenging activity were assessed to determine the antioxidant Activity. Sample was extracted according to D'Abrosca et al. (2017). 5 g fresh and 3 g dried samples were minced and immersed in 10 mL methanol (80% v/v). After homogenizing the mixture, it was centrifuged at 3000 x g for 10 minutes. All extractions were then performed in triplicate, and the supernatant was filtered using Whatmann No. 1 filter paper.

Determination Total Phenolic content

According to (Vidinamo et al., 2022), total phenolic content in fresh and dried samples was determined by Folin-Ciocalteu reagent (FCR) method. 6 ml deionized water and 0.5 mL Folin- Ciocalteu reagent (FCR) were added with 0.1 mL extracted sample solution. The aliquots were mixed thoroughly for five minutes and then 2 mL of 15% Na₂CO₃ was added. The mixture was allowed to stay in the dark for 2 hr at room temperature. The absorbance was measured at 760 nm by UV-Vis spectrophotometer. Gallic acid calibration curve from different gallic acid concentrations (0 – 20 µg/mL) was used to estimate the total phenolic content, which was expressed as gallic acid equivalents (mg GAE/ g sample).

Determination DPPH scavenging activity

The total antioxidant activity was determined by DPPH scavenging activity according to Adiletta et al. (2018b). 2 ml

extract of different concentrations was mixed by vortex with 3.5 mL of 6 x 10⁻⁵ M DPPH methanol solution. The reaction mixture was kept in the dark at room temperature for 30 minutes. The hue changed from purple to yellow as a result of the DPPH (1,1-diphenyl-2-picrylhydrazyl) solution being reduced, indicating the reaction's progress. Using methanol as a blank and a control sample devoid of extract, the UV-Vis spectrophotometer measured absorbance at 517 nm. The percentage of DPPH radical inhibition was computed using the following formula (Deng et al., 2018; Wang et al., 2018). The necessary sample concentration (mg/ml) to inhibit 50% DPPH radical scavenging activity was calculated using the EC 50 values. An antioxidant activity (%) and sample concentration (mg/ml) graph was used to determine the EC 50.

Quality Analysis

Determination of amino acids composition

This amino acid assay was carried out using the Sykam Auto Amino Acid Analyzer (Sykam AAA S 433-D, catalog number 1120002). For this investigation, the chromatographic technique was used. 500 ml of hydrolysis solution, consisting of 300 ml of 37% HCL, 200 ml of DI water, and 0.5 g of phenol, was used to dissolve 250 mg of the sample. After then, the samples were kept at 120 °C for a whole day. Following incubation, the samples were filtered through Whatman No. 01 Filter Paper. It is necessary to prepare the samples using buffer pH-adjustable 1M and 7.5M NaOH solutions. The pH of the sample was between 2.9 and 3.1. The sample was diluted to 250 mL after the pH was adjusted, and 100 mL was then extracted from this stock. A 0.45-M syringe filter was then used to further filter the sample. The autosampler was then used to store the samples. The following stages are finished using the methods described by Zhou et al. (2022). Based on their charges and retention durations, the samples are separated into the columns. After compiling all the data, one standard solution was run in comparison to this standard curve to estimate the amount of protein present in the samples.

L-Ascorbic acid determination

Approximately 7g of sample was crushed in porcelain mortar for 5 minutes with gradual addition of 50 ml buffer solution (potassium phosphate 0.02 M, pH = 2.5 by phosphoric acid). The mixture was sonicated for 10 minutes in a dark flask and filtered through a filter paper. 10 µL of extract was injected into the HPLC chromatography. High performance liquid chromatography (HPLC), in isocratic conditions with an All-Tima C-18 column (250 mm × 4.6 mm, 5 mm particle size) was used to determine L-ascorbic acid (Ramallo and Mascheroni, 2012). A mobile phase of buffer: acetonitrile (98:2, v/v) was used at a flow rate 1 mL/min. Quantification of L-ascorbic acid was carried out by comparing the retention time and the peak area of the sample with a standard reference at λ = 254nm. 100 mL of L-ascorbic acid (1 mg/mL) was used as a standard solution and then diluted to 1/10, 1/50, and 1/100. 10 µL of 0.02

mg/mL standard solution (external standard procedure) was injected to obtain the reference peak area. The reference chromatogram was done every 2 hr during this assay.

Determination of Citric Acid Content

To determine the acidity of a fruit juice sample, 10 grams of the juice are weighed into a beaker, followed by the addition of 25 milliliters of distilled water to facilitate accurate titration. The sample is then titrated with 0.1M sodium hydroxide using phenolphthalein as an indicator. The weight of citric acid is calculated using the formula, where 192.43 g/mol represents the molecular weight of citric acid. The percentage of total acidity is determined by the formula. Typically falling between 0.39% and 1.1%, the normal range for citric acid content in fruit juices provides a benchmark for assessing the results obtained through this precise and standardized titration method, ensuring reliable measurements of acidity levels.

Determination of β -Carotene

β -Carotene was determined as $\mu\text{g/g}$ using UV-vis Spectrophotometer in dried jackfruit flour. For extraction, 1 g sample was homogenized into 5 ml chilled acetone and kept for 15 min at 4°C with occasional shaking. Mixture was centrifuged at $13700 \times g$ for 10 min after 10 minutes vortex mixing at high speed. Precipitation was re-extracted with 5ml acetone and both supernatants were filtered through the Whatman filter paper. The absorbance of the extract was determined.

Determination of microbial load

Bacterial and fungal load was determined in dried samples using standard plate count agar and Martin Rose Bengal agar. 1000 milliliters of saltwater (0.89% NaCl) were used to dissolve 18 grams of agar. In a test tube, 1 g of the material was combined with 9 ml of autoclaved saline (0.89% NaCl). To determine the bacterial and fungal loads, serial dilution was used. Agar medium plates were filled with 1 ml of the sample, which was then incubated for 24 hours at 37° C for bacteria and 72 hours for fungi at 30° C. Microbial colonies were counted manually (A.O.A.C., 2000). Certain pathogens, such as *S. aureus*, *Salmonella* and *Shigella*, *E. coli*, *V. cholerae*, *C. perfringens*, and yeasts and molds, were also the subject of the inquiry. This thorough microbiological investigation offers a strong basis for evaluating the sample's safety and quality because it was carried out in compliance with recognized methods and regulatory criteria (Sanjee and Karim, 2016).

Determination of Water absorption index and water solubility index

The Water Absorption Index (WAI) and Water Solubility Index (WSI) were measured following a modified version of the method described by Asaduzzaman et al. (2013). For the

WAI determination, 0.83 g of dried flour was mixed with 10 ml of water in a 30 ml centrifuge tube and centrifuged at 4000 rpm for 30 minutes. After centrifugation, the supernatant was carefully decanted, and the residue remaining in the tube was weighed along with the tube. The WAI was calculated by subtracting the weight of the empty tube from the weight of the tube with residue, then dividing by the weight of the dried sample and multiplying by 100. The same initial procedure was followed to determine the WSI; however, after centrifugation, the supernatant was transferred to a pre-weighed dish and dried at 70°C until a constant weight was achieved. The dried solids were then weighed, and the WSI was calculated by subtracting the dish weight from the weight of the dried solids plus dish, dividing the result by the weight of the original dried sample, and multiplying by 100. This approach allows for the assessment of the flour's capacity to absorb water and the amount of soluble solids released during hydration, providing valuable insights into the functional properties of the sample.

Culinary applications

Vegan meat formulation

Combine jackfruit flour, gram flour, water, onion, garlic, smoked paprika, cumin, salt, and pepper in a mixing bowl. Mix well until a dough forms. Divide the dough into 4 equal portions and shape each portion into a patty. Heat oil in a frying pan over medium heat. Add the patties and cook for 3-4 minutes on each side or until golden brown. Serve the patties on buns with your favorite toppings, such as lettuce, tomato, avocado, and vegan cheese. The recipe is inspired by the versatility of jackfruit in vegan cooking, as demonstrated in various jackfruit recipes, such as jackfruit meatball tacos and jackfruit chicken nuggets. The patties are prepared following the above procedures. The finished product is a delicious and nutritious alternative to traditional meat patties, with less than 200 calories per patty and a lower glycemic index. The use of jackfruit flour, gram flour, and a variety of seasonings makes these patties a flavorful and satisfying option for vegans and non-vegans alike. The recipe is a great way to incorporate jackfruit into the diet and enjoy its nutritional benefits.

Sensory Evaluation

Seven untrained panelists who were hired at the BCSIR performed the sensory evaluation of burger patties made with jackfruit flour. Texture, flavor, taste, fragrance, adhesiveness, and general acceptability were all evaluated on a five-point hedonic scale, with 1 denoting "dislike extremely" and 5 denoting "like extremely," with 3 denoting "good." For every sensory attribute, the panelists' scores were computed, and the average values were shown together with the standard deviation. When the average score was equal to or higher than "3.0," the prepared dishes were deemed acceptable (Moreira et al., 2015).

Effect of Jackfruit Flour Bread on Blood Glucose

In a study conducted at BIRDEM General Hospital, Shahbag, Dhaka, 40 volunteers aged 34 to 72 years were randomly assigned to experimental and control groups. They were served two pieces of Roti made with either jackfruit flour or wheat flour, along with a fried egg with onion. This meal was consumed twice, with a one-week interval between sessions and the type of Roti was reversed. Blood samples were collected at 0, 30 minutes, 1 hour, and 2 hours after consumption, using the glucose oxidase method for analysis. Socio-demographic data, anthropometric measurements, and blood pressure were also recorded. The study employed blinding procedures to ensure impartiality among volunteers and laboratory personnel throughout the experiment.

RESULT

Determination of nutritional attributes

Nutritional studies have highlighted the potential benefits of dry jackfruit flour. Analysis of moisture content and dry matter is crucial in nutritional reporting, as these factors directly influence the flour’s nutritional composition, stability, and shelf life (Table 1). Proximal values were calculated and depicted in Table 2. In our studies, jackfruit flours were found to be rich in proteins, carbohydrates and gluten-free. Moisture content was also very high. Crude fat and ash contents were found to be low. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) analysis revealed that jackfruit seeds are particularly rich in potassium (K), followed by calcium (Ca) and sodium (Na) (Table 3). Additionally, the flour was identified as a significant source of the micronutrient zinc (Zn).

Table 1: General properties of Initially prepared dried green jackfruit powder

Moisture %	Crude Protein %	Carbohydrate%	Lipid %	Gluten %	Ash %	Crude fiber %
6.04 ± 0.37	12.27 ± 1.39	37.57 ± 3.67	1.59 ± 0.04	0%	3.28± 0.35	12.21

Table 2: Proximate composition of dry green jackfruit flour from our studies

pH	Total Soluble Solids (°brix)	Shrinkage ratio	Water Solubility Index (%)	Water absorption index(g/g)
5.02	19 ± 0.01	0.24± 0.02	14.45±2.04	2.58± 0.04

Mineral content analysis

The mineral composition of dry green jackfruit flour was assessed, revealing significant amounts of key minerals per

100g, including potassium (1540 mg), calcium (205 mg), and sodium (21.6 mg).

Table 3: Mineral composition of dry green jackfruit flour from our studies

Analytes	Amount (mg/100g)
K	1540 ± 0.04
Ca	205 ± 0.01
Na	21.6 ± 0.02

Amino acid composition analysis

Figure 1 presents the amino acid composition analysis of jackfruit powder, with notable amounts of key amino acids, including aspartic acid (20.6%), glutamic acid (11.4%), and alanine (10.0%), contributing to its nutritional value. The presence of essential amino acids such as lysine (6.0%) and leucine (6.7%) underscores its potential as a protein source.

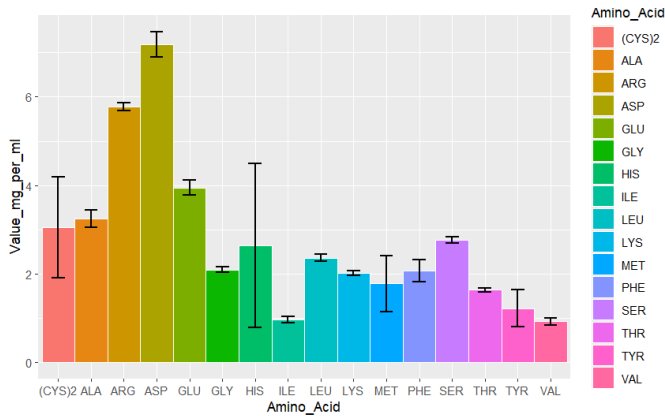


Figure 1: Amino acid composition analysis

Bioactive Composition

The biochemical composition analysis of jackfruit powder revealed its content of citric acid (0.00024 mg/g), ascorbic acid (0.01 mg/g), total carotenoids (0.13 µg/g), and total phenolic content (18.98 mg/g GAE equivalent) (Table 4). The DPPH activity showed an IC50 value of 2.9 mg/g, indicating its potential antioxidant properties (Figure 2).

Table 4: Biochemical composition analysis

citric acid (mg/g)	0.00024 ± 0.04
Ascorbic acid (mg/g)	0.01 ± 0.02
Total Carotenoid (µg/g)	0.13 ± 0.007
Total Phenolic Content (mg/g GAE equivalent)	18.98± 0.34
DPPH activity IC50 (mg/g)	2.9

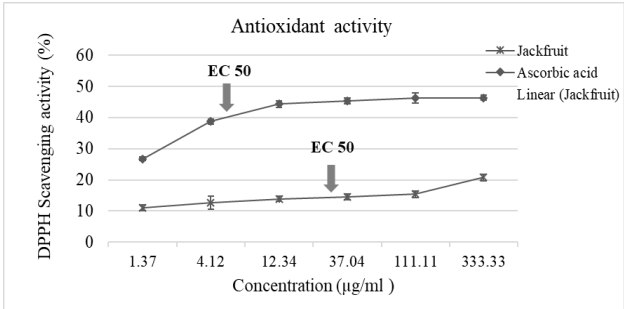


Figure 2: 1,1-Diphenyl-2-picrylhydrazyl radical scavenging activity analysis

Heavy Metal Status

The heavy metal analysis of dried jackfruit flour demonstrated the presence of lead (0.1898 mg/kg), which is within permissible limits, while cadmium was not detected, indicating its absence. Chromium was found in negligible amounts (0.0 mg/kg), and manganese content was also low, highlighting the safety of the product in terms of heavy metal contamination (Table 5).

Table 5: Heavy metal status of dried algae powder

Parameter	Concentration(mg/kg)
Lead (Pb)	0.1898 (<0.25 mg/kg)
Cadmium (Cd)	Not detected (<0.25 mg/kg)
Chromium(Cr)	0.0 (<0.50 mg/kg)
Manganese(Mn)	0.0

Microbial load Determination

The findings of the microbiological analysis for a 25-gram sample after 15 minutes of UV exposure were as follows: 1.1×10 CFU for the Total Bacterial Count (TBC), 1.1×10 CFU for the Total Yeast & Molds Count (colony-forming units), and no Shigella or Salmonella sp. Furthermore, the sample did not include any Hemorrhagic Escherichia coli. These results show that the sample's microbial

contamination has decreased, guaranteeing its safety and quality.

Effect of Jackfruit Flour Bread on Blood Glucose

The study observed a significant increase in mean blood glucose levels between 0 minutes and 30 minutes after consuming jackfruit flour bread (+1.1 mmol/l, p<0.001) and wheat flour bread (+0.84 mmol/l, p<0.001). Between 30 minutes and 1 hour after consumption, the increase was +0.11 mmol/l (p=0.687) for jackfruit bread and +0.18 mmol/l (p=0.346) for wheat bread. However, between 1 and 2 hours after consumption, there was a significant decrease in blood glucose levels for both jackfruit flour bread (-1.2 mmol/l, p<0.001) and wheat flour bread (-1.1 mmol/l, p<0.001) (Table 7).

Table 7: Glycemic levels of study participants before and after eating bread (roti) made by jackfruit flour and wholemeal wheat flour

Blood sample	Jackfruit flour	Wheat flour	P value
Before meal (0 minutes)	9.5 (4.1)	8.8 (3.3)	0.246
30 minutes after eating bread	10.5 (3.9)	9.6 (3.4)	0.104
1 hour after eating bread	10.6 (3.7)	9.8 (3.3)	0.102
2 hours after eating bread	9.4 (3.5)	8.7 (3.4)	0.146

Data are presented as mean (± SD)
P value <0.05. Paired samples t-test.

DISCUSSION

The research paper on dry green jackfruit flour explores its nutritional composition, bioactive properties, and potential applications in culinary and health contexts. This discussion synthesizes the findings and implications of the study, drawing on relevant literature and highlighting key aspects of the research. The moisture content of Our prepared product is 6.04%, that is low in comparison with wheat flour source. According to SyedaAfifa et al. (2012), wheat flour's moisture content ranged from 9.11% to 9.79%.

Dry green jackfruit flour is rich in essential nutrients, as evidenced by proximal analysis. It contains significant amounts of proteins (12.27%), carbohydrates (37.57%), and essential minerals such as potassium, calcium, and sodium. The findings of Ahmad et al. (2005), who found that wheat flour contains 10.32% to 11.58% proteins, is corroborated by these numbers, which are greater than the market-available flour supply. The flour's protein content, complemented by

essential amino acids like lysine and leucine, suggests its potential as a valuable protein source, particularly in vegan and vegetarian diets. Low levels of crude fat (1.59%) and ash (3.28%) content indicate that the flour is suitable for low-fat diets and is highly digestible. The previous study showed that the lower level of total ash and crude fiber contents recorded on a dry weight basis were $0.15 \pm 0.07\%$, $1.95 \pm 0.02\%$, $2.72 \pm 0.03\%$ (Ruparathna et al., 2021).

The presence of bioactive compounds such as ascorbic acid (9.01 ± 0.02 mg/g), total carotenoids (0.13 ± 0.007 ug/g), and phenolic compounds (18.98 ± 0.34) underscores the flour's potential health benefits. Ascorbic acid, known for its antioxidant properties, contributes to the flour's nutritional profile (Adoménienė et al., 2022). The high total phenolic content and DPPH scavenging activity (2.9 mg/g) highlight its antioxidant capacity, crucial for combating oxidative stress and associated diseases (Chaudhary et al., 2023).

Significant levels of potassium (1540 ± 0.04), calcium (205 ± 0.01), and sodium (21.6 ± 0.02) were found in 100 grams of jackfruit flour, according to mineral analysis. These minerals are essential for several physiological processes, such as nerve transmission, bone health, and muscular function (Ali & A. A. H., 2023). According to the study's heavy metal analysis, the jackfruit flour was safe to eat because its levels of lead (0.1898 (<0.25 mg/kg)) and cadmium (Not detected (<0.25 mg/kg)) were below acceptable bounds. Low levels of manganese and negligible amounts of chromium further support the product's safety against heavy metal contamination.

A flour's suitability for food processing and formulation is largely determined by its functional qualities, especially its water absorption index (WAI) and water solubility index (WSI). These factors improve sensory qualities and consumer acceptance by influencing food products' texture, viscosity, and shelf stability. Jackfruit flour's high fiber content and loss of starch crystalline structure may be the cause of its 14.45 ± 2.04 g/g WAI (Asaduzzaman et al., 2013). The semi-crystalline structure of the starch had an impact on the WSI, which was measured at $14.45 \pm 2.04\%$. Water molecules can form hydrogen bonds with the free hydroxyl groups of amylose and amylopectin when starch granules are disrupted (Eliasson and Gudmundsson, 1996).

Jackfruit flour demonstrated versatility in culinary applications, particularly in vegan meat formulations and bakery products. Sensory evaluation highlighted positive attributes such as texture, flavor, and overall acceptability, making it a promising ingredient in food product development (Figure 3). *Salmonella*, *Shigella*, and hemorrhagic *E. coli* were not found in the manufactured product's microbiological study, which indicated low levels of microbial contamination. This shows that, in accordance with the guidelines set forth by the International Microbiological Standard, the produced biomass is both safe and of high quality for use as a feed source. The study on jackfruit flour's effect on blood glucose levels provides insights into its potential role in managing glycemic

responses (Maradesha et al., 2022). While initial increases in blood glucose were observed after consumption, subsequent decreases suggest potential benefits for glycemic control, possibly due to the flour's fiber content and low glycemic index.

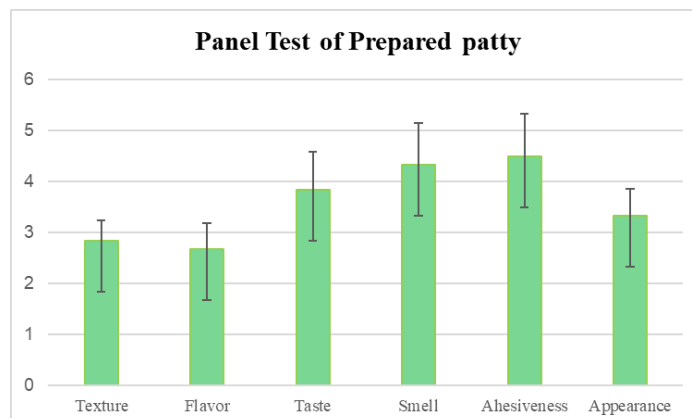


Figure 3: Panel test of prepared burger patty

In conclusion, dry green jackfruit flour offers a range of nutritional and functional benefits, supported by its rich composition of proteins, essential minerals, and bioactive compounds. Its safety profile regarding heavy metals and its positive sensory attributes further enhance its potential as a sustainable and health-promoting food ingredient. Future research could explore its impact on broader health outcomes and further optimize its application in functional foods and dietary interventions.

Acknowledgement

Funds for this work were received from the project of "Establishment of Research Facilities on Processing of Safe and Healthy Dry Fish and Indoor Farming at BCSIR Centre Dhaka and Chattogram", Ministry of Science and Technology, Bangladesh.

Authors' contributions

AT and FAM performed the overall experiment. AT performed statistical analysis, organized and interpreted all data and drafted the final version of the manuscript. SMRI performed amino acid and proximate analysis. MRH provided overall guidance, technical support and revised the manuscript. MRK designed the entire experiment, supervised the workflow, reviewed the manuscript, and managed the fund.

Conflict of Interest

There are no conflicts of interest declared by the authors.

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